Robert C. Colwell, Reg. No. 27,431     (650) 326-2400
Applicant:  Takahiko TAKEDA, et al.
Titl  :  Storage System and Method of Controlling the Same
Atty D ck t No.  16869P-085400
She t  1  f  14

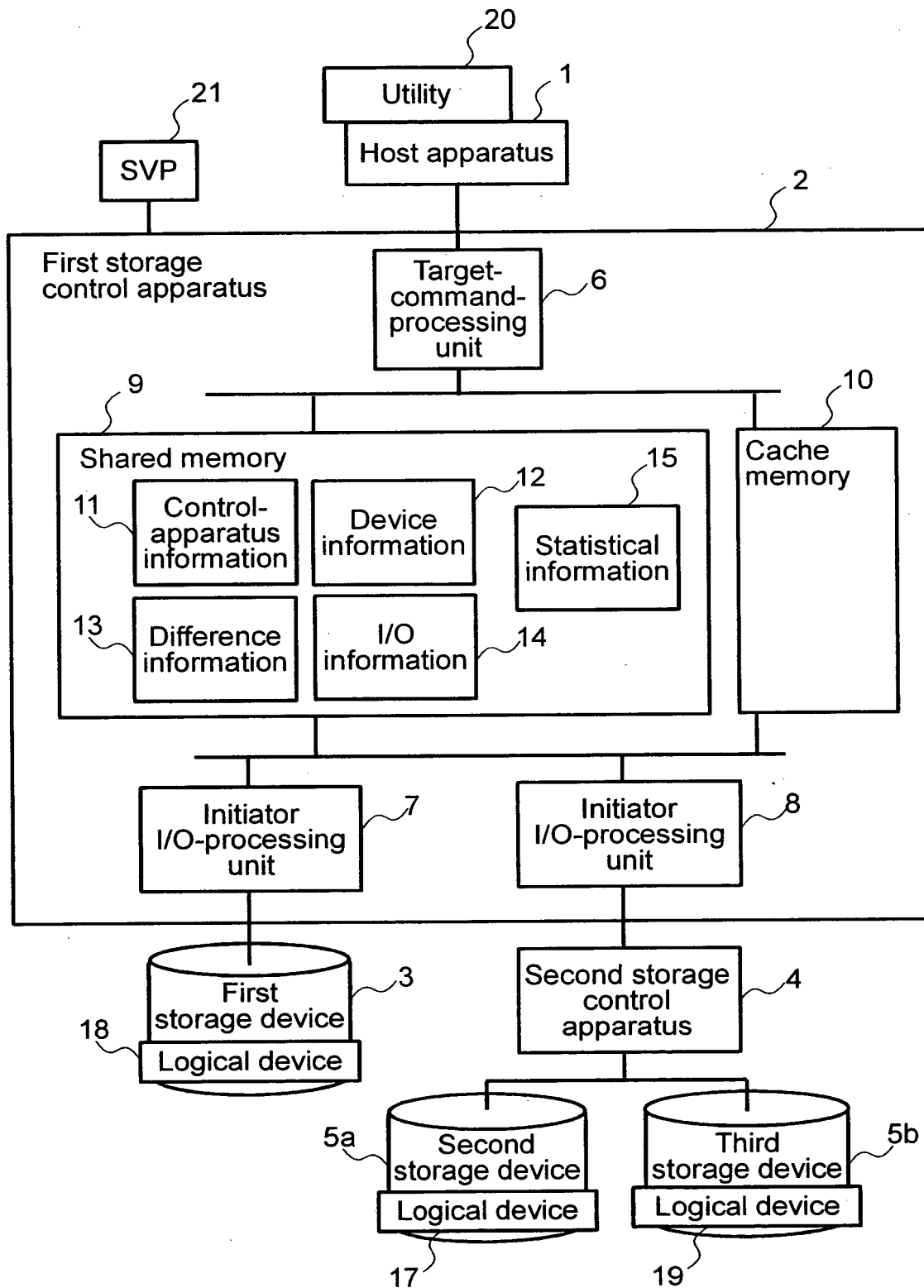# FIG.1

Robert C. Colwell, Reg. No. 27,431    (650) 326-2400
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# FIG.2

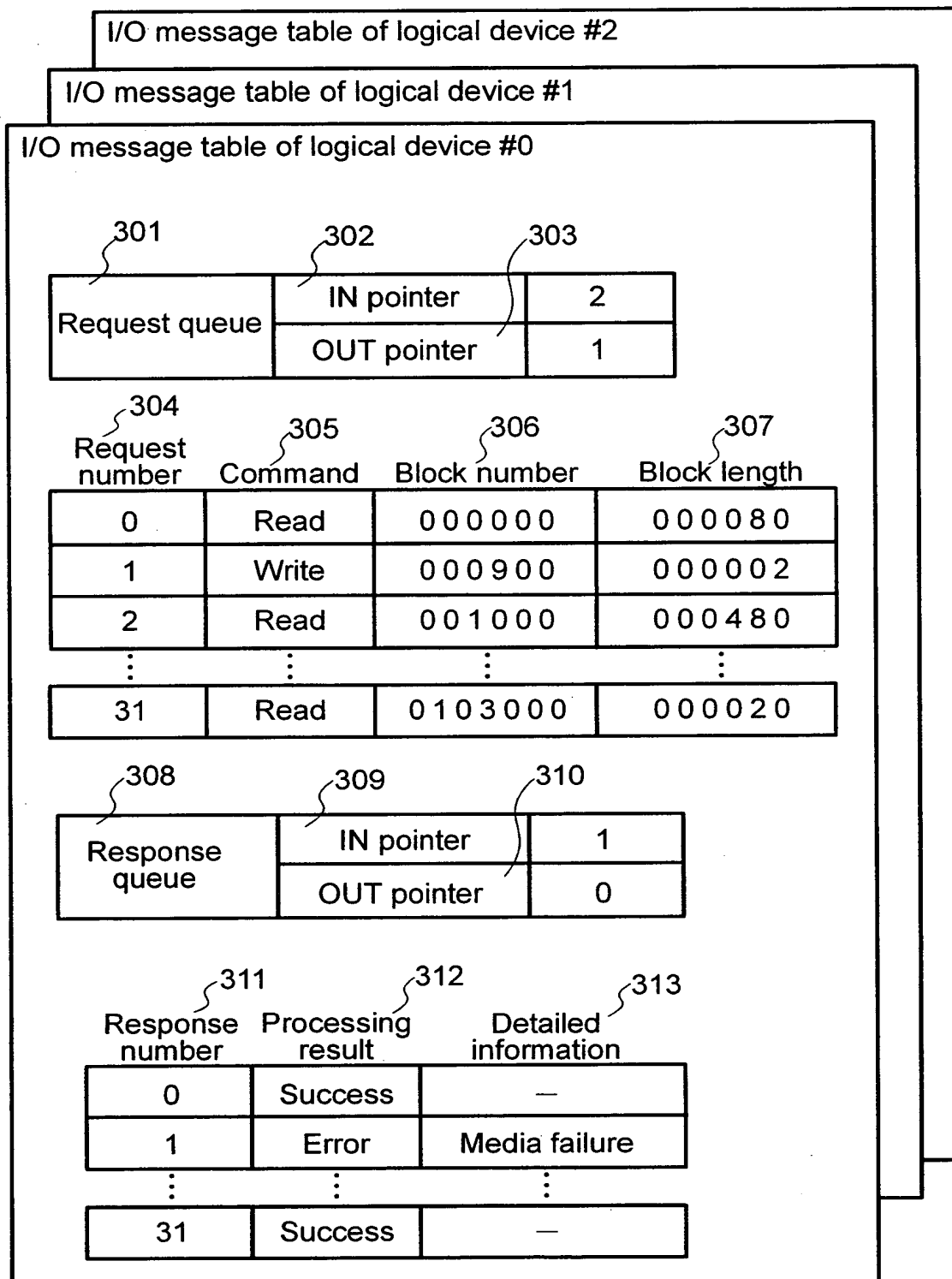| Control-apparatus number | Case location | Initiator control unit number | Node Name | Address |
|---|---|---|---|---|
| 0 | Self | 0 | HTC | 0000E8 |
| 1 | Other | 1 | SBC | 0100E4 |
| 2 | Not applicable | Not applicable | Not applicable | Not applicable |

101  102  103  104  105

# FIG.3

| Logical-device number | Control-appratus number | Storage-device number | Pair state | Pair number | Attribute | Pair logical device number | Copy pointer |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | Split | 0 | Primary | 1 | Not applicable |
| 1 | 1 | 0 | Split | 0 | Auxiliary | 0 | Not applicable |
| 2 | 1 | 1 | Simplex | Not applicable | Primary | Not applicable | Not applicable |
| 3 | Not applicable | Not applicable | Simplex | Not applicable | Primary | Not applicable | Not applicable |

201  202  203  204  205  206  207  208

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# FIG.4

I/O message table of logical device #2

I/O message table of logical device #1

I/O message table of logical device #0

| 301 Request queue | 302 IN pointer | 303 2 |
|---|---|---|
| | OUT pointer | 1 |

| 304 Request number | 305 Command | 306 Block number | 307 Block length |
|---|---|---|---|
| 0 | Read | 0 0 0 0 0 0 | 0 0 0 0 8 0 |
| 1 | Write | 0 0 0 9 0 0 | 0 0 0 0 0 2 |
| 2 | Read | 0 0 1 0 0 0 | 0 0 0 4 8 0 |
| ⋮ | ⋮ | ⋮ | ⋮ |
| 31 | Read | 0 1 0 3 0 0 0 | 0 0 0 0 2 0 |

| 308 Response queue | 309 IN pointer | 310 1 |
|---|---|---|
| | OUT pointer | 0 |

| 311 Response number | 312 Processing result | 313 Detailed information |
|---|---|---|
| 0 | Success | — |
| 1 | Error | Media failure |
| ⋮ | ⋮ | ⋮ |
| 31 | Success | — |

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# FIG.5

0 1 2 3 4 5 6 7 · · ·

**Pair number 0**

0 0 1 0 1 1 1 0 · · ·
1 1 1 1 1 1 0 0 · · ·
·                ·
·                ·
0 0 0 0 1 0 0 0 · · ·

**Pair number 1**

0 0 0 0 0 0 0 0 · · ·
0 0 0 0 0 0 0 0 · · ·
·                ·
·                ·
0 0 0 0 0 0 0 0 · · ·

**Pair number N**

0 0 0 0 0 0 0 0 · · ·
0 0 0 0 0 0 1 1 · · ·
·                ·
·                ·
1 1 1 1 0 0 0 0 · · ·

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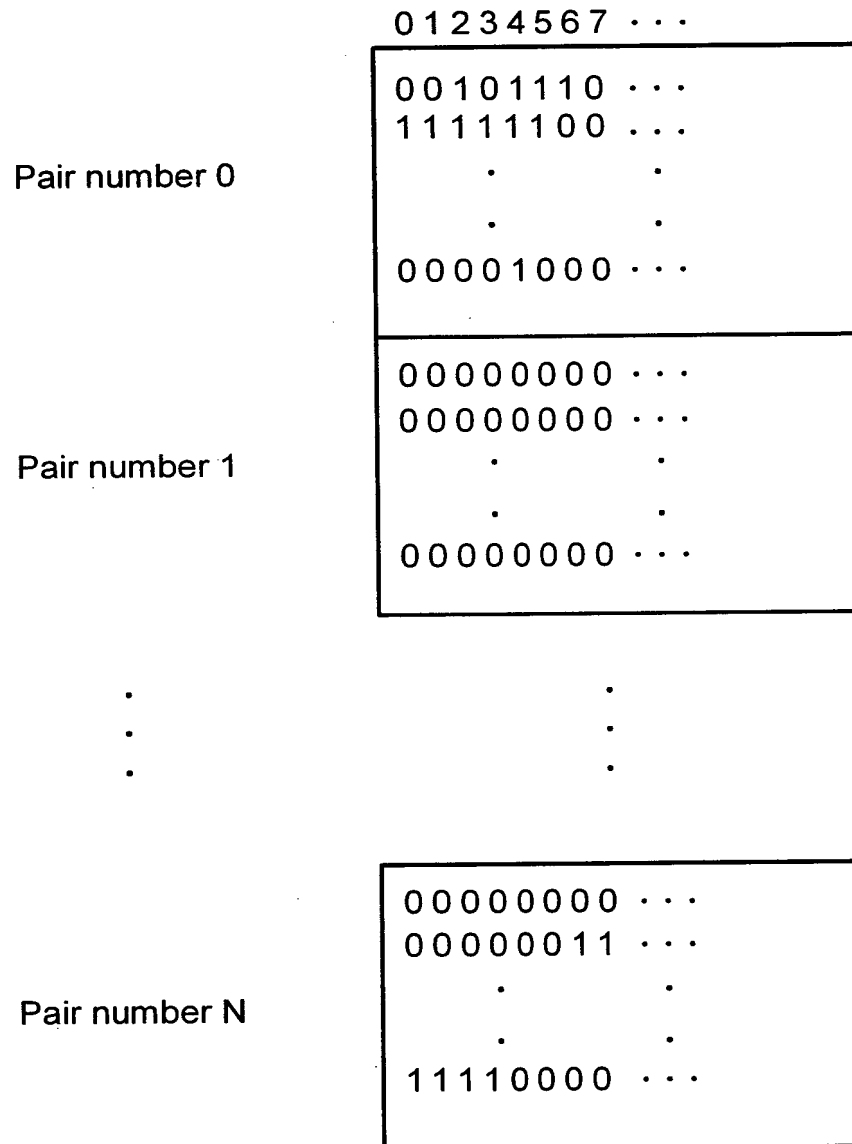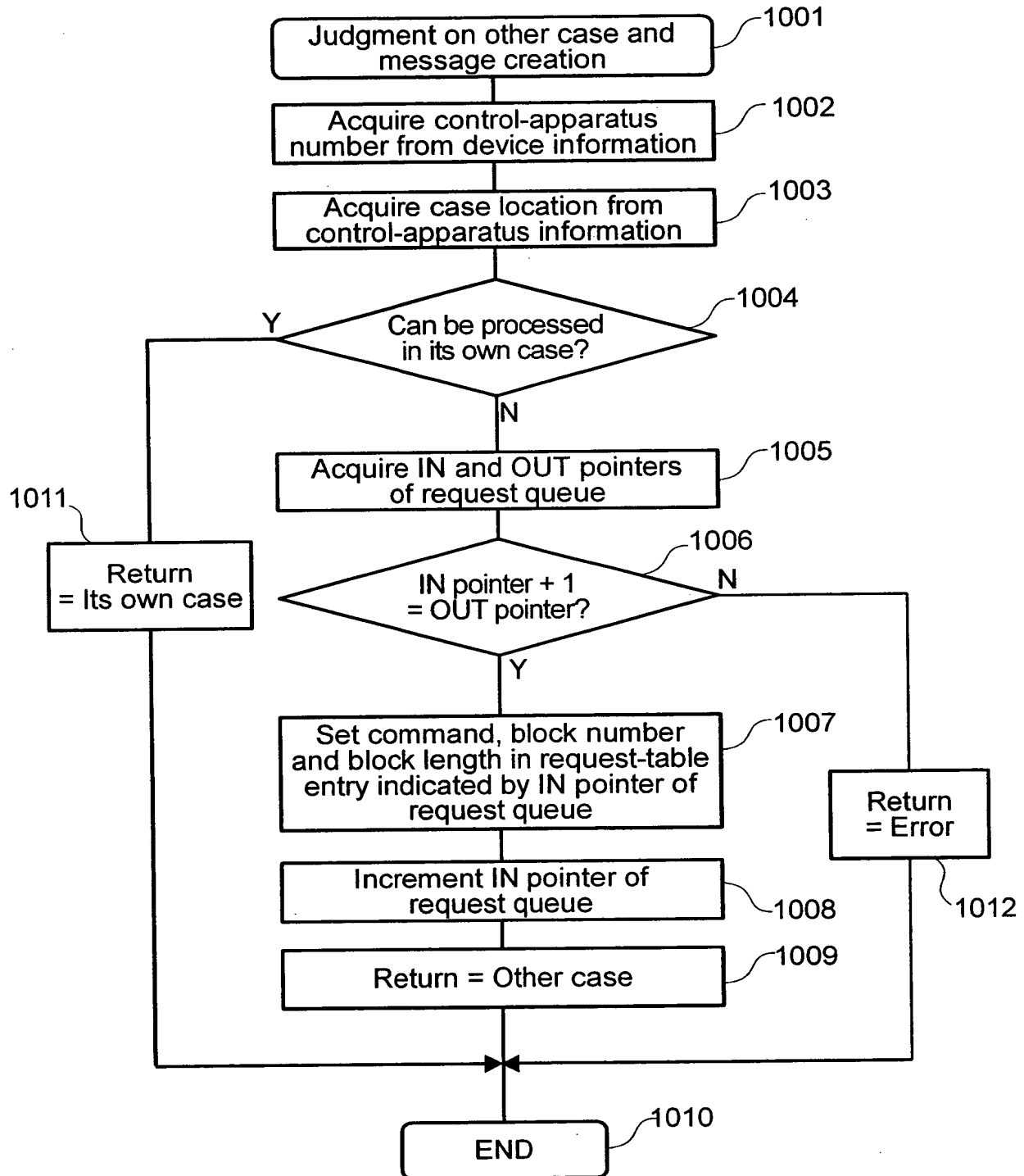Sh et 5 of 14

# FIG.6

| Logical-device number | Access-I/O counter | Read-I/O counter | Write-I/O counter |
|:---:|:---:|:---:|:---:|
| 0 | 0020 | 0010 | 0010 |
| 1 | 0010 | 0006 | 0004 |
| 2 | 0100 | 0100 | 0000 |
| 3 | 0000 | 0000 | 0000 |

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# FIG.7

Inputs:
Logical-device number

Judgment on other case and message creation ⌐1001

Acquire control-apparatus number from device information ⌐1002

Acquire case location from control-apparatus information ⌐1003

Can be processed in its own case? ⌐1004

Y

1011 — Return = Its own case

N

Acquire IN and OUT pointers of request queue ⌐1005

IN pointer + 1 = OUT pointer? ⌐1006

N

Y

Set command, block number and block length in request-table entry indicated by IN pointer of request queue ⌐1007

Return = Error

Increment IN pointer of request queue ⌐1008

1012

Return = Other case ⌐1009

END ⌐1010

# FIG.8

Inputs:
Logical-device number

Issue initiator unit command ⟶ 2001

Acquire IN and OUT pointers of request queue ⟶ 2002

IN pointer ≠ OUT pointer? ⟶ 2003

N

Y

Acquire command, block number and block length from request-table entry indicated by OUT pointer of request queue ⟶ 2004

Acquire control-apparatus number and storage-device number from device information ⟶ 2005

Acquire control-apparatus address from control-apparatus information ⟶ 2006

Return = NO request ⟶ 2011

Transmit command ⟶ 2007

Increment OUT pointer of request queue ⟶ 2008

Return = Successful command transmission ⟶ 2009

END ⟶ 2010

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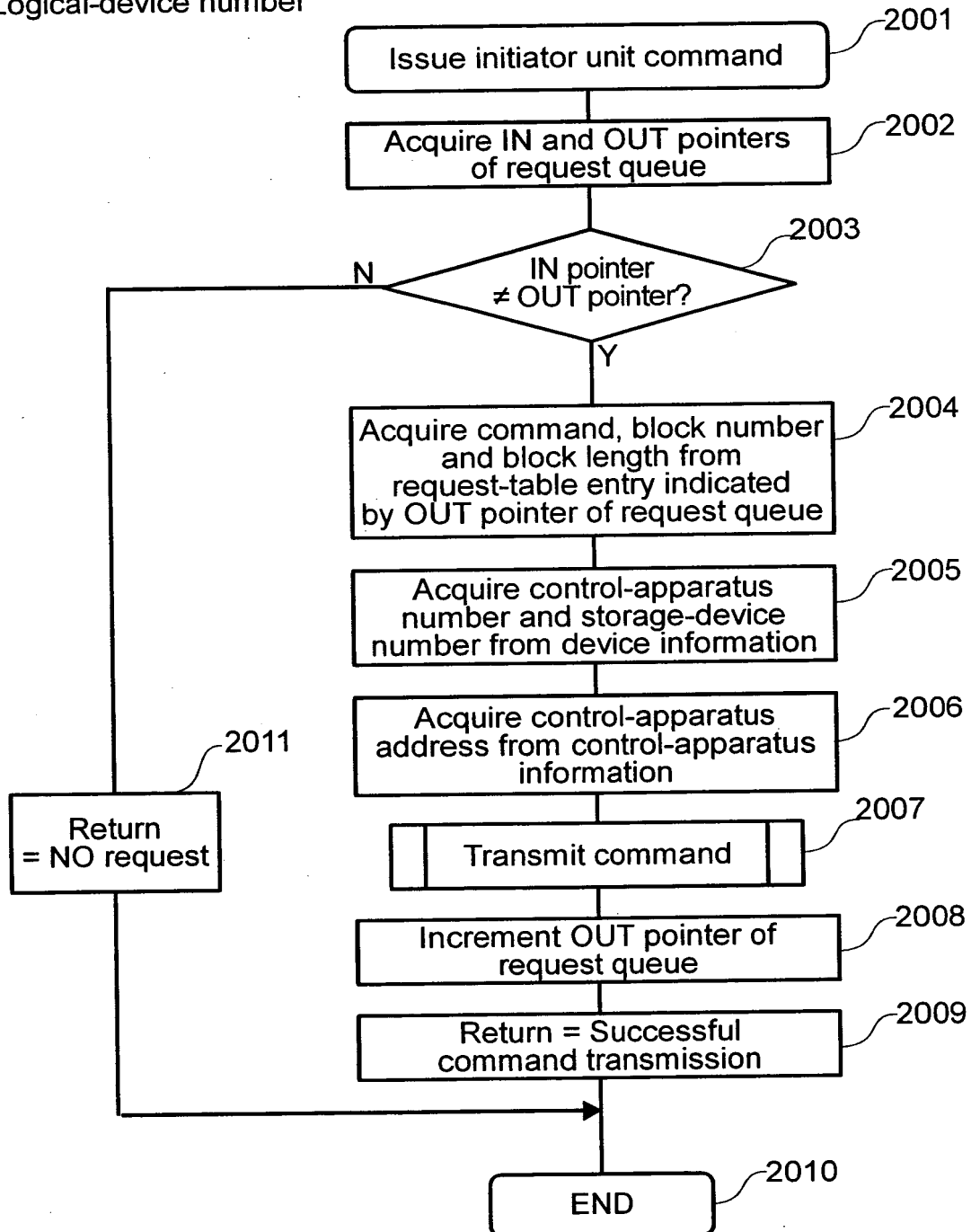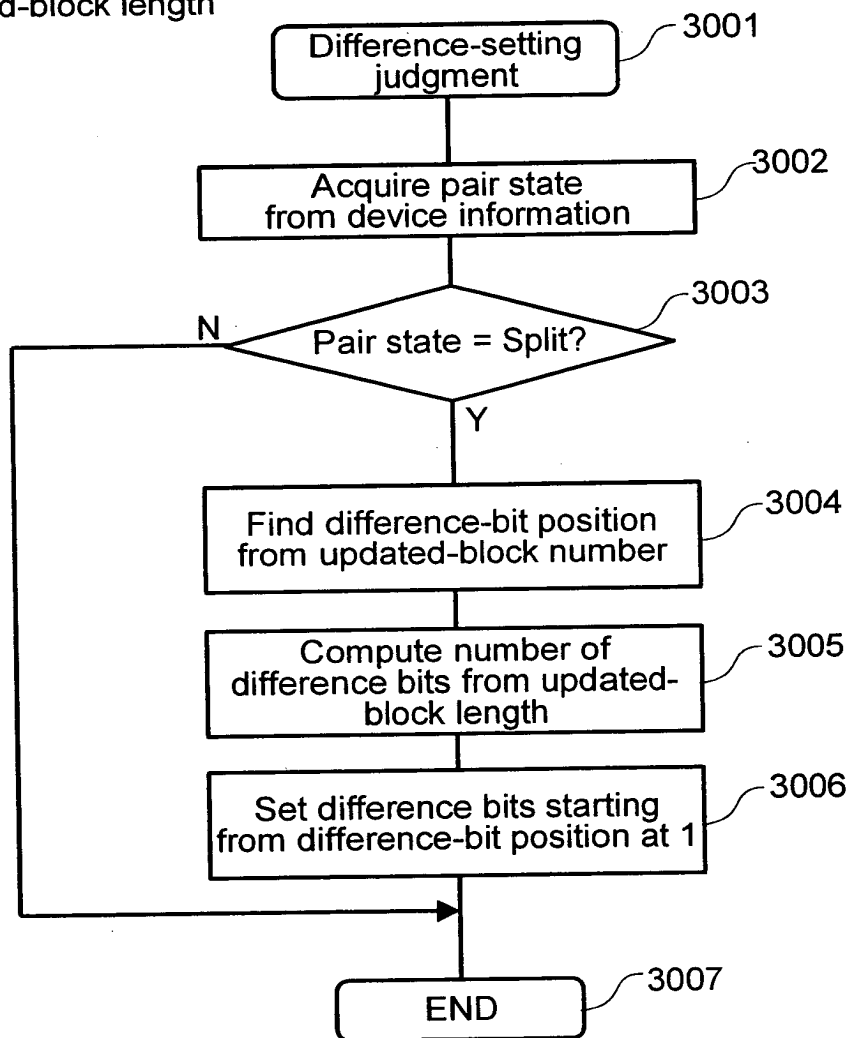Applicant: Takahiko TAKEDA, et al.
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# FIG.9

Inputs:
Logical-device number,
updated-block number
and updated-block length

```
┌─────────────────────────┐
│  Difference-setting      │──── 3001
│  judgment                │
└─────────────────────────┘
            │
┌─────────────────────────┐
│  Acquire pair state      │──── 3002
│  from device information │
└─────────────────────────┘
            │
      ◇─────────────◇
 N   ╱ Pair state = Split? ╲ ──── 3003
◄───╱                       ╲
      ◇─────────────◇
            │ Y
┌─────────────────────────┐
│  Find difference-bit     │──── 3004
│  position from updated-  │
│  block number            │
└─────────────────────────┘
            │
┌─────────────────────────┐
│  Compute number of       │──── 3005
│  difference bits from    │
│  updated-block length    │
└─────────────────────────┘
            │
┌─────────────────────────┐
│  Set difference bits     │──── 3006
│  starting from           │
│  difference-bit position │
│  at 1                    │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│         END              │──── 3007
└─────────────────────────┘
```

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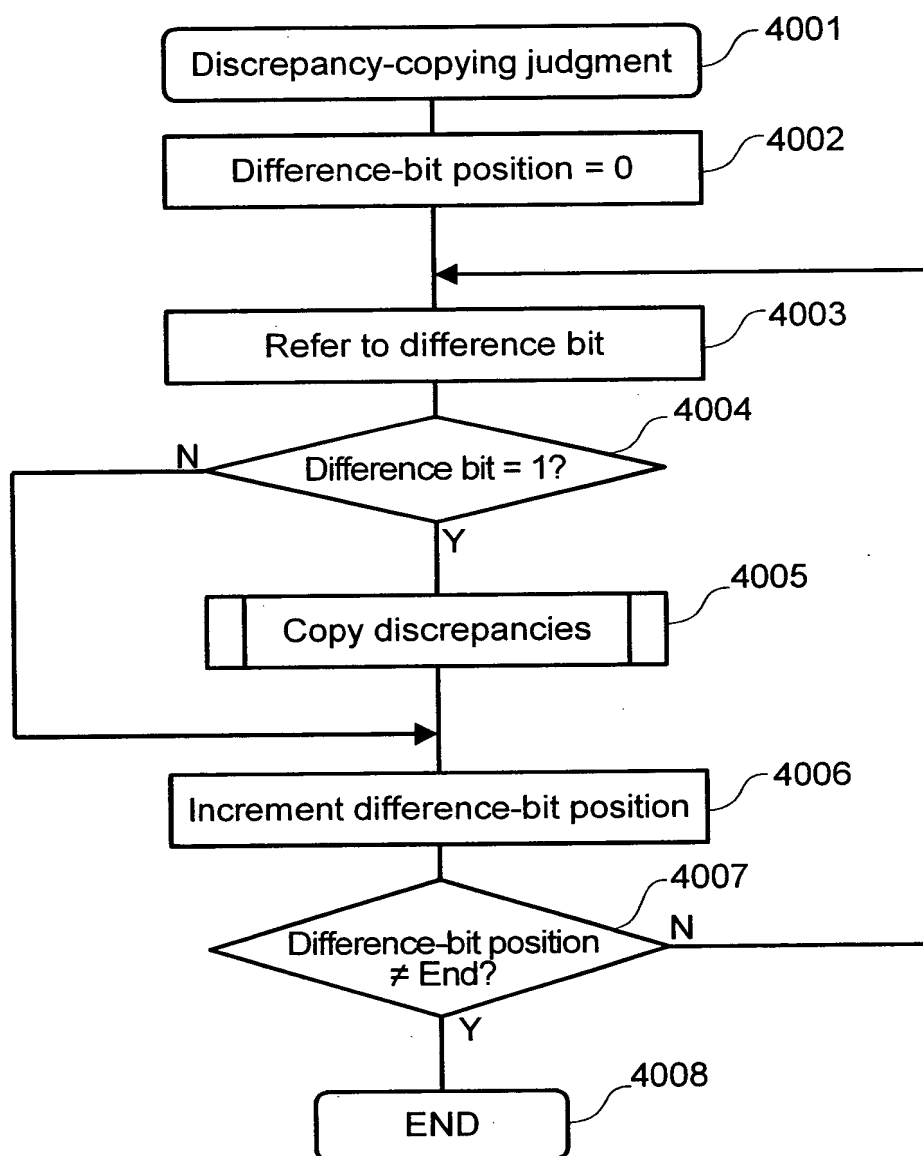**Applicant:** Takahiko TAKEDA, *et al.*
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# FIG.10

Inputs:
Logical-device number

Discrepancy-copying judgment — 4001

Difference-bit position = 0 — 4002

Refer to difference bit — 4003

Difference bit = 1? — 4004

N

Y

Copy discrepancies — 4005

Increment difference-bit position — 4006

Difference-bit position ≠ End? — 4007

N

Y

END — 4008

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# FIG.11

Inputs:
Logical-device number,
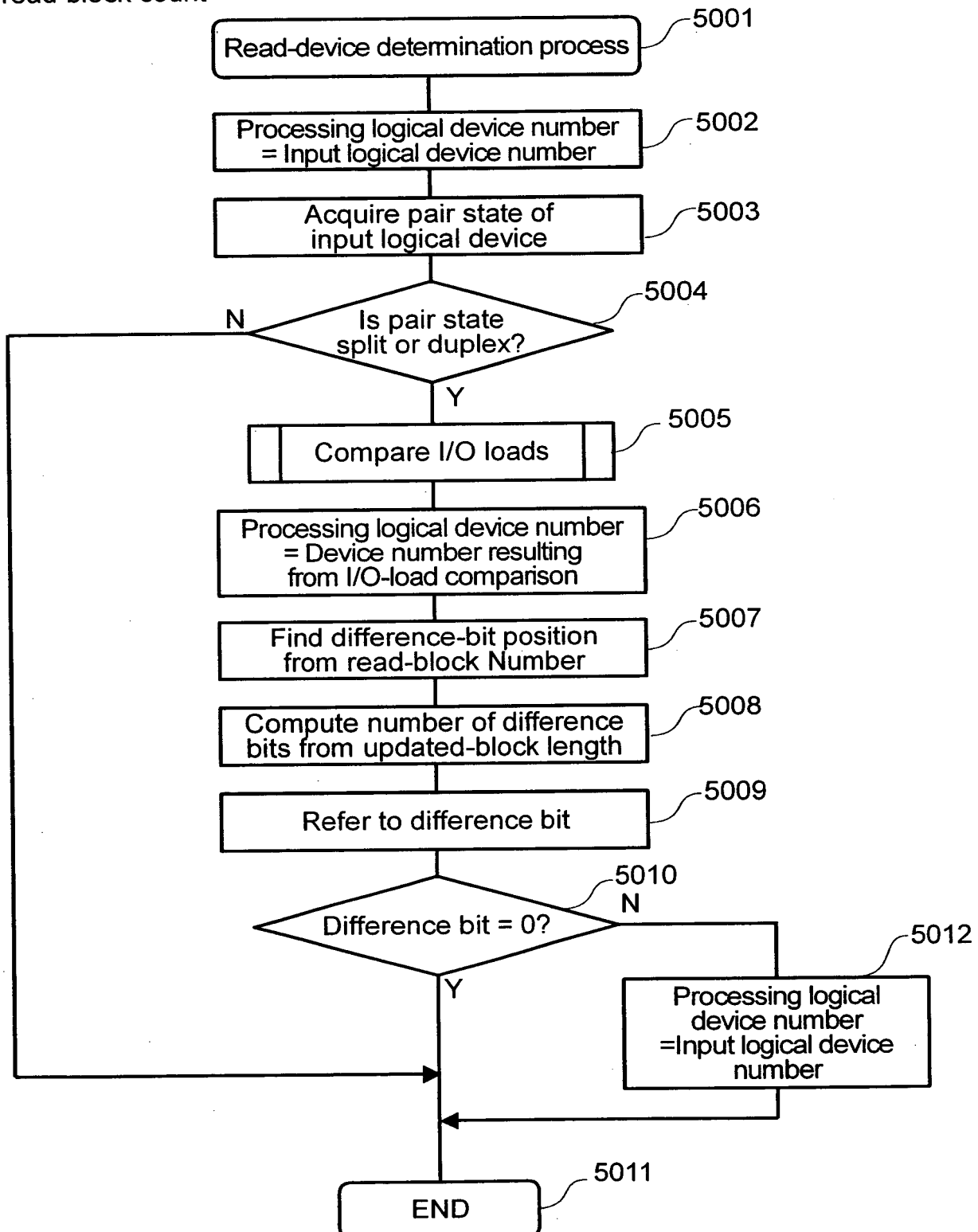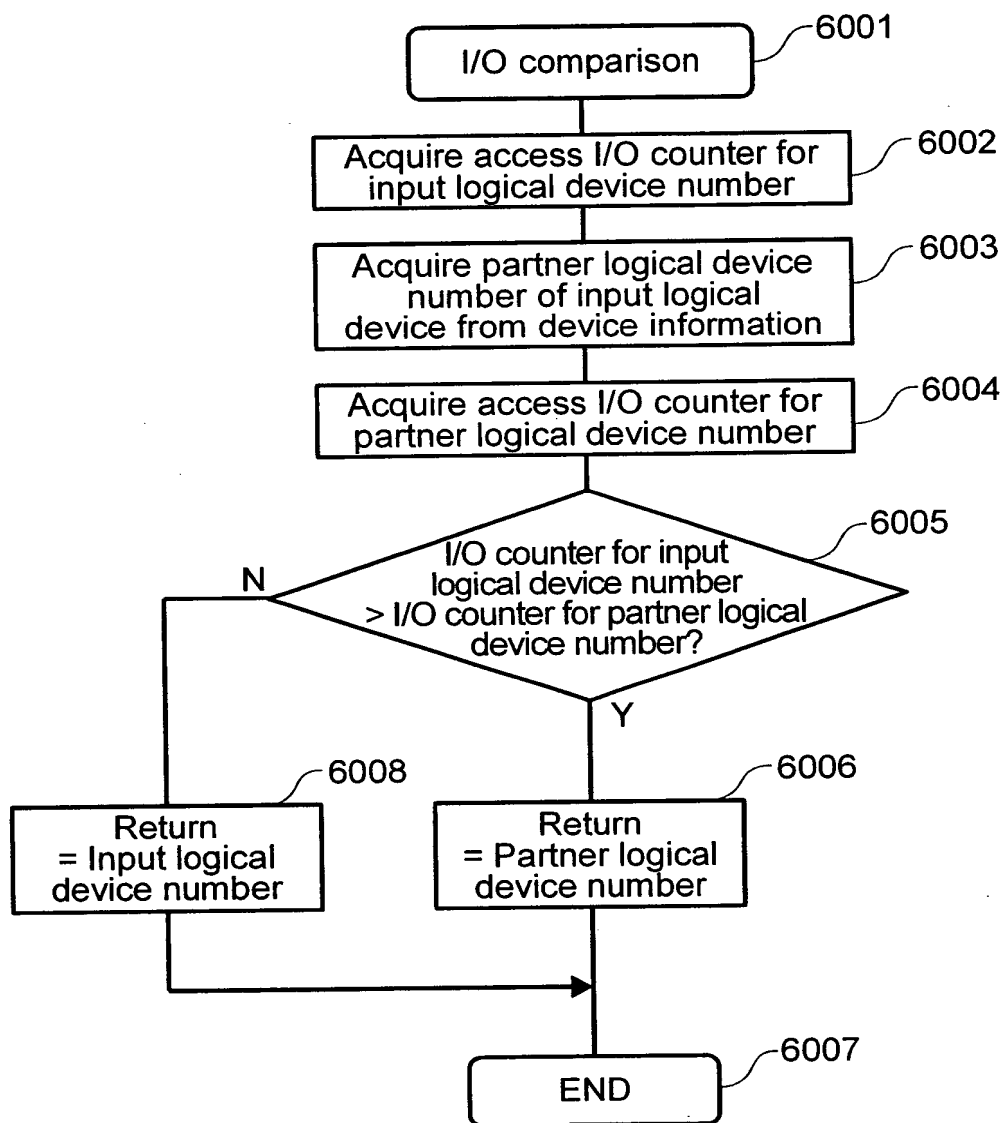read-block number and
read-block count

Read-device determination process —5001

Processing logical device number
= Input logical device number —5002

Acquire pair state of
input logical device —5003

Is pair state
split or duplex? —5004
N

Y

Compare I/O loads —5005

Processing logical device number
= Device number resulting
from I/O-load comparison —5006

Find difference-bit position
from read-block Number —5007

Compute number of difference
bits from updated-block length —5008

Refer to difference bit —5009

Difference bit = 0? —5010
N

Processing logical
device number
=Input logical device
number —5012

Y

END —5011

# FIG.12

Inputs:
Logical-device number

I/O comparison — 6001

Acquire access I/O counter for input logical device number — 6002

Acquire partner logical device number of input logical device from device information — 6003

Acquire access I/O counter for partner logical device number — 6004

I/O counter for input logical device number > I/O counter for partner logical device number? — 6005

N

Y

Return = Input logical device number — 6008

Return = Partner logical device number — 6006

END — 6007

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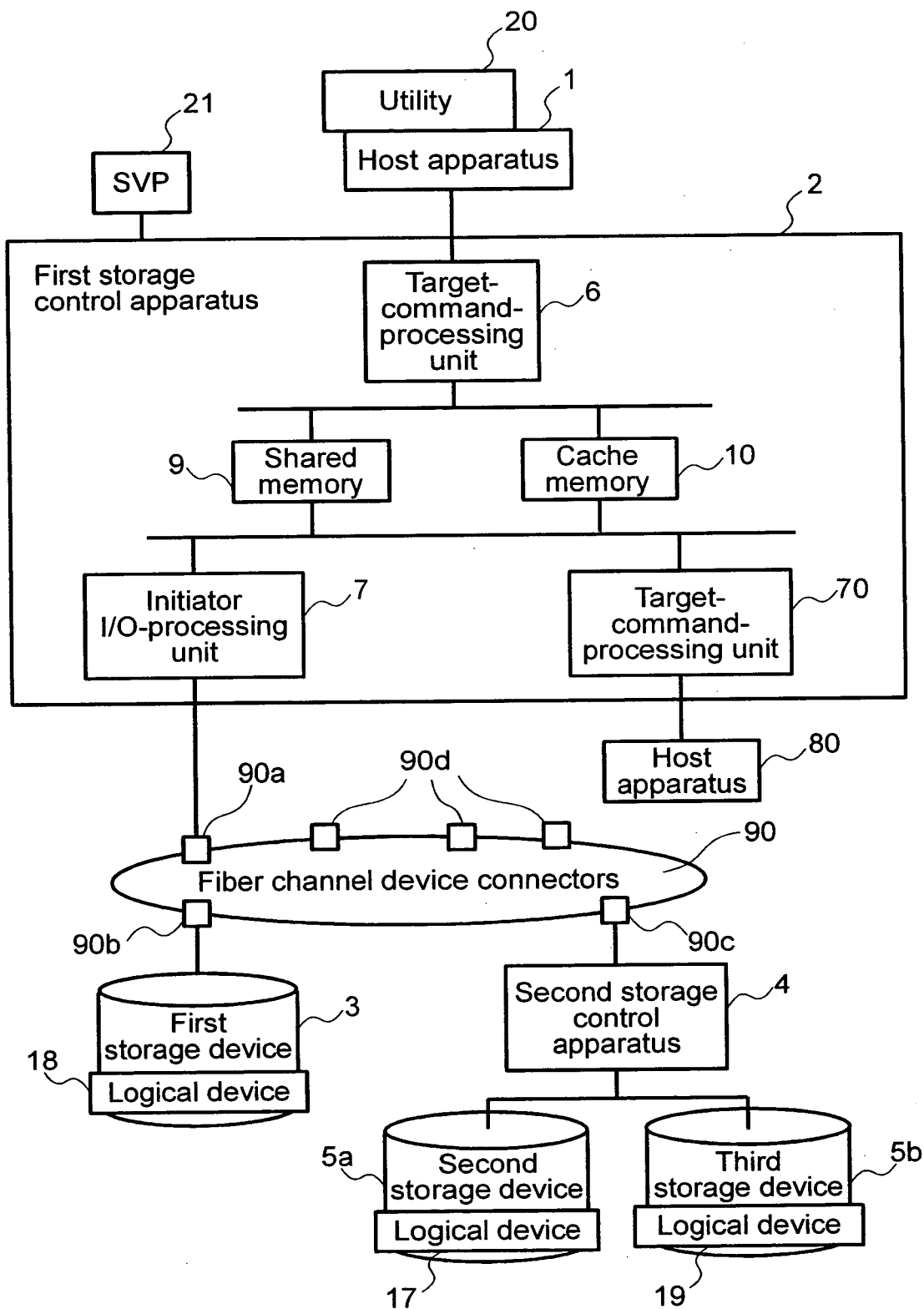Applicant: Takahiko TAKEDA, *et al.*
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# FIG.13

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# FIG.14

| Control-apparatus number | Case location | Initiator control unit number | Node name | Address |
|---|---|---|---|---|
| 0 | Self | 0 | HTC | 0000E8 |
| 1 | Other | 0 | SBC | 0000E4 |
| 2 | Not applicable | Not applicable | Not applicable | Not applicable |

101  102  103  104  105

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# FIG.15